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Reproductive Success of Grasshopper Sparrows in Relation to Edge

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ABSTRACT -- Using an index based on observations of breeding behaviors, we estimated reproductive success of 31 territorial grasshopper sparrows (*Ammodramus savannarum*) on Conservation Reserve Program fields in southeast Nebraska. Reproductive success was 52%, and no difference was detected between birds holding interior (>100 m from the edge) vs. edge territories. However, grasshopper sparrows appeared to avoid nesting within 50 m of edge habitats. Territories ranged from 0.36 - 1.24 ha, and territory size did not differ between successful and unsuccessful males.

Key words: *Ammodramus savannarum*, Conservation Reserve Program, edge effect, grasshopper sparrow, grassland birds, Nebraska.

Declining populations of grassland birds have generated increased interest in recent years. This guild is experiencing declines greater than any other group of birds in the United States (Peterjohn and Sauer 1993). Conversion of grassland habitat to agricultural and urban uses may be one contributing factor. Additionally, studies of grassland fragmentation have suggested that some species are sensitive to patch size, in much the same way as are certain forest birds (Herkert 1994, Vickery et al. 1994). Most studies have focused on species presence, although estimates of reproductive success would provide a more complete measure of area-sensitivity. Pairing success of ovenbirds (*Seiurus aurocapillus*) has been found to be lower in fragmented forests than in large, intact forests (Gibbs and Faaborg 1990). Edge effects may be important determinants of reproductive success in fragmented landscapes. Rates of nest predation and brown-headed cowbird (*Molothrus ater*) parasitism of grassland birds are higher near field edges than in interior locations (Johnson and Temple 1990, Burger et al. 1994). Burger et al. (1994) showed that proximity to a wooded edge influenced predation rates more than patch size.

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We estimated breeding abundances of grassland birds on 10 Conservation Reserve Program (CRP) fields in southeast Nebraska from 1991-94. Grasshopper sparrows (*Ammodramus savannarum*) were one of the most abundant species encountered. This species declined nationally by 69% from 1966 -1991 according to Breeding Bird Survey data (Herkert 1994), and little information exists on its reproductive success. CRP fields may offer potential habitat for this species, but if reproductive success is low, CRP fields could be acting as sink habitats (sensu Pulliam 1988). In 1994, we tested the hypothesis that reproductive success of grasshopper sparrows is lower for birds holding edge territories than for those holding interior territories. Since nests are difficult to find and searching methods can be destructive, we used an index of reproductive success based on behavioral observations that does not rely on locating nests (Vickery et al. 1992a). This method provides an index of fitness, but does not measure actual fitness because the number of offspring is not determined. We also mapped territories to determine if reproductive success was related to territory size independent of the location of the territory.

STUDY AREAS AND METHODS

In 1994 grasshopper sparrows were present on four of the ten fields used in a larger study of avian use of CRP fields in Lancaster and Saunders counties, Nebraska (see Delisle and Savidge 1997). Fields ranged in size from 20 - 40 ha and study plots within fields were approximately 15 ha. Three fields were planted with a cool-season grass mixture containing primarily brome grass (*Bromus* spp.), and one field was planted with a warm-season grass mixture of big bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), Indian grass (*Sorghastrum nutans*), and little bluestem (*Schizachyrium scoparium*). All fields were planted in 1987 or 1988. Edges bordering fields included roadsides, wooded draws, and fencelines separating the CRP plot from crop fields. The amount of woody vegetation along edges ranged from 5 - 50%. Reproductive success of each territory-holding male was estimated by using the ranking system described by Vickery et al. (1992a). Rankings ranged from one for unpaired males present for at least four weeks to seven for birds showing evidence of fledging success in two broods. Individual males were visited 13 - 16 times from 18 May to 27 July. We used 13 randomly selected visits to determine the rank of males with greater than 13 visits. Using this random subset of visits did not change the final rank, which indicates that 13 visits were sufficient to accurately assess rank. The interval between visits was four to eight days, and we felt confident that changes in rank would not be missed. Each bird was observed for 30 minutes unless a clear indication of change in rank, e.g., food being carried for the first time, was determined sooner. Males were classified as having high success (rank 5 or higher - fledging success in at least one brood) or low success (rank 4 or lower - fledging success not evident). Using a combination of the territory flush (Wiens 1969) and spot mapping techniques, territories were mapped. Based on studies of predation rates in grasslands (Johnson and Temple 1990, Burger et al. 1994), we first defined a territory as 'edge' if $\geq$50% of its area was within 50 m of an edge and as 'interior' if <50% of its area was within 50 m of an edge. Using 100 m as the edge criteria, we also examined reproductive success. Since only one territory had $\geq$50% of its area within 50 m of a field edge, statistical analysis was not possible. Thus, we used the 100 m distance as our point separating edge territories from interior territories. While differential rates of predation in response to edge proximity are undoubtedly affected by habitat and edge type, effects rarely are known to extend more than 100 m (Paton 1994). Chi-square analysis with Yates correction for continuity (Zar 1984) was used to compare reproductive success of edge and interior territories separately for the 50 m and 100 m classifications. A t-test was used to test for a difference in territory size between successful and unsuccessful males. Spearman rank correlation was used to detect a relationship between reproductive success rank and territory size.

RESULTS

Thirty-one male grasshopper sparrows held territories for greater than or equal to four weeks. Fourteen territories were classified as interior and seventeen were classified as edge (Table 1). Sixteen (52%) territories received a rank of five or higher indicating fledging success in at least one brood. There was no difference in reproductive success between edge and interior territories ($\chi^2 = 0.3124$, $P > 0.05$). No unpaired males held territories for greater than or equal to four weeks (rank one) although one male remained unpaired for 12 days and then left the study site. Territories ranged in size from 0.36-1.24 ha, with a mean size of 0.77 ha. There was no difference in size between high success and low success territories, between interior and edge territories, and no relationship between reproductive rank and territory size ($P > 0.05$). Of the ten nests found, none was located within 50 m of an edge, eight were at least 100 m from an edge, and the mean nest distance ($\pm$ SE) from an edge was 119 m ($\pm$ 11.8 m).

Table 1. Ranks of male grasshopper sparrows holding territories on CRP fields in southeast Nebraska.

Rank	Associated behavior [a]	Number of Territories	No. Edge/ No. Interior [b]
1	Unpaired male	0	-
2	Male and female present	2	1/1
3	Nest building, laying, incubating	2	1/1
4	Food delivered to nestlings	11	7/4
5	Fledging success in 1 brood	9	5/4
6	Fledging success + nestling success	6	3/3
7	Fledging success in 2 broods	1	0/1

[a] Condensed from Vickery et al. 1992a.

[b] Interior territories defined as having <50% of area within 100 m from the nearest edge.

DISCUSSION

The index provided a measure of reproductive success for each male grasshopper sparrow holding a territory. This level of information would not have been available from nest monitoring since rarely can all nests be found, especially for ground-nesting birds. Bias can exist when all nests are not found since well-concealed nests may experience lower rates of predation. Although we did not know the location of most nests, eight of the ten nests found were placed in the correct edge/interior category. Using this method, Vickery et al. (1992a) estimated a success rate of 25% for grasshopper sparrows in Maine, in contrast to our estimated success rate of 52%. Few of our territories were ranked lower than four. The availability of mates appeared sufficient since only one unpaired male was observed, and this bird did not remain in the study area. We found no relationship between reproductive success and territory size. Average territory size was similar to that found on a Pennsylvania farm (0.82 ha, Smith 1963) and a Wisconsin grassland plot (0.81 ha, Wiens 1969). Using a boundary delineation technique different from ours, Kendeigh (1941) found territories averaged 1.38 ha on a prairie in Iowa.

Grasshopper sparrows may avoid nesting close to field edges. On Minnesota prairies, only four of the forty-six grasshopper sparrow nests found were located within 45 m of the field edge (Johnson and Temple 1990). None of the ten nests found on our fields were located close to an edge, with the nearest distance being 60 m. Only one territory had ≥50% of its territory within 50 m of an edge. Helzer (1996) found that grasshopper sparrow abundance increased sharply after the first 50 m from cornfield edges, and after 75 m from wooded edges.

Nest predation is considered the most common cause of reproductive failure for many songbirds (Martin 1992) and is known to be a major cause of nest failure for grassland birds (Wray et al. 1982). Predation rates may be influenced by nest concealment and predator abundance. The two types of CRP grass plantings may offer different levels of nest concealment, although we were not able to test this because only one field was planted to warm-season grasses. Concealment may be less important when predators, such as some species of snakes, locate prey by non-visual means (Best 1978), and when predation on nests is incidental to a predator's search for other prey types (Vickery et al. 1992b). Predator densities may be higher near field edges than at interior locations (Gates and Gysel 1978), which results in higher predation rates near edges (Johnson and Temple 1990). We made no attempt to estimate predator type or abundance in our study. However, few American crows (*Corvus brachyrhynchos*) or blue jays (*Cyanocitta cristata*), visual predators known to use edge habitats, were present during a four-year study of avian use of these CRP fields (Delisle and Savidge 1997).

Rates of nest parasitism by brown-headed cowbirds may also be influenced by nest concealment and distance of the nest from field edges. Brown-headed cowbirds use shrubs and trees along fencelines to locate and monitor nests of potential hosts using adjacent grasslands. Rates of nest parasitism have been shown to be higher near wooded edges (Johnson and Temple 1990) where brown-headed cowbirds concentrate their activity. Unlike birds of eastern woodlands, grasshopper sparrows have evolved with brown-headed cowbirds, and may avoid edge habitats as a strategy for reducing brown-headed cowbird parasitism.

Edge habitat in southeast Nebraska consists largely of linear strips such as wooded draws, fencelines with scattered woody vegetation, windbreaks, and roadsides with scattered trees. If predators and brown-headed cowbirds use these strips to penetrate fields, but concentrate their activity in a narrow zone along the edge, bird species that avoid this edge zone would not be greatly impacted by edge predators or brown-headed cowbirds. To support viable populations of species that avoid edge habitats, fields must be large and have a high interior-to-edge ratio. Several studies have generated incidence functions to predict a species' probability of occurrence on fields of different sizes. These functions have been used to estimate minimum-area requirements for the grasshopper sparrow. Vickery et al. (1994) suggested a minimum field size of 100 ha in Maine, and Herkert (1994) recommended a minimum of 30 ha for fields in Illinois. In Nebraska, Helzer (1996) defined a minimum field size of 12 ha, but found perimeter to area ratio to be a more important predictor of grasshopper sparrow presence than patch size. These studies did not evaluate reproductive success on fields of different sizes. Our study was not designed to test the importance of field size. However, our results suggest that 20 - 40 ha fields may function as source habitat for grasshopper sparrows.

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